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THE HENRY DRAPER MEMORIAL.

THE third annual report, just published, shows that the researches which constitute the Henry Draper Memorial have consisted for the last three years in the photographic study of the spectra of the stars. While this subject will continue to be the principal one under investigation, Mrs. Draper has decided to extend the field of work undertaken so as to include the study of the other physical properties of the stars by photography. The first research undertaken is now rapidly approaching completion, the plans for the study of the southern stars have been matured, and this study will soon be begun. The detailed study of the spectra of the brighter stars is making progress, and a large piece of photometric work will soon be undertaken with a new telescope.

The Bache telescope, which has an 8-inch photographic doublet as an objective, is used for the catalogue of spectra of bright stars. The photographs cover the entire sky north of —25°, with exposures of about five or ten minutes. About 28,000 spectra of 10,800 stars have been examined, including nearly all stars visible in Cambridge, of the seventh magnitude or brighter. The catalogue is now nearly ready for the printer.

In November, 1888, the photographs required to cover the sky north of the equator for the catalogue of spectra of faint stars were nearly finished. It was expected that in two months the observations would be completed. The telescope, which was the same as that used in the previous research, was, however, wanted for photographing the solar eclipse of Jan. 1, 1889. It was accordingly sent to Willows, Cal., where it was mounted, and the greater portion of the remaining photographs were taken there. It was then sent to Peru. The few remaining photographs, including the repetition of those found on further examination to be unsatisfactory, will be taken in Peru. The sky from —25° to the south pole will be covered for bright stars as well, and the resulting photographs sent to Cambridge and reduced, as in the case of the northern stars. The advantages of discussing all stars from the north to the south pole according to one system are very great, and are here secured for the first time in so extensive an investigation. If no unforeseen difficulty arises, the photographs will all be completed during the next two years.

The 11-inch refractor, with one, two, or four large prisms over its objective, has been employed in the detailed study of the spectra of the brighter stars throughout nearly every clear night, until stopped by the morning twilight: 686 photographs have been taken, most of them with an exposure of two hours. With the present photographic plates, about 570 stars north of —30° are bright enough to be photographed with one prism, 170 of them with two prisms, and 87 of them with four prisms. To obtain the best possible result, some of the photographs must be repeated many times. The difficulty is increased by the invariably hazy appearance of the lines in some spectra, like that of *α Aquilæ*, which was at first attributed to poor definition of the photograph. It is expected that the work will be completed during the next year by original or repeated photographs of 228 stars with one prism, of 64 with two, and of 12 with four. In general, stars as bright as the fourth magnitude can be satisfactorily photographed with one prism, the spectra obtained being about an inch long. Fainter stars, if of a bluish color, give sufficiently distinct images, in some cases good results being obtained with stars of the seventh magnitude. For example, fourteen stars in the Pleiades are well photographed with this apparatus. With four prisms, much longer spectra are obtained, and many more lines are visible. But certain differences in the character of the spectra are better shown with the smaller dispersion. Numerous photographs have been taken of the variable stars *o Ceti* and *β Lyræ*. The changes in the spectrum of the latter star seem to be undoubted; those of *o Ceti*, if any, to be slight. Various peculiarities in the spectra of individual stars have been detected. One photograph of *ζ Ursæ Majoris* shows the K line distinctly double, and others show it single. Many photographs will be required to determine the law of its variation, if this is due to changes in the star itself. Bright lines were detected in the spectrum of *φ Persei*, putting it in a class in which only two or three other stars are known to fall. In the double star *β Cygni* the two components have spectra of different types,—an important consideration in the theories regarding their formation. The brighter component is of the second type; the fainter, of the first.

Ordinary photographic plates are not sensitive to rays of much greater wave-length than the F line, or 486. By staining the plates with various coal-tar products, the range of sensitiveness may be greatly extended. With erythrosine, the spectrum extends to the wave-length 590. The sodium line D is distinctly seen to be double in the photographs of *α Bootis* and *α Aurigæ*. Various experiments were also made with cyanine, but the plates were not sufficiently sensitive to give good results. The entire length of the spectrum with four prisms, including the portion obtained by erythrosine, is about six inches and a half.

A beginning has been made of the measures of the positions of the lines in the spectrum. A scale of fortieths of an inch has been ruled on glass, and the positions of the lines read off with the aid of a magnifying-glass. Twelve of the photographs of *α Canis Majoris* have been studied in this way. The spectrum of this star is traversed by the hydrogen lines, which are strong, and by other lines which are so faint that they are only visible when the dispersion is large and the definition good. The catalogue thus formed contains about 320 lines. The average deviation of the measures of the same line on different plates is about 0.05 of a millionth of a millimetre, or 0.05 centimetres on the scale of Angström's map. If the line occurs in the solar spectrum, these measures will generally identify it. In other cases the exact position